liberated after showing them to curious friends.

J. Stanford Brown

SPECIAL ARTICLES

RIGHT-HANDEDNESS AND PERIPHERAL VISION

Of right-handedness, three facts seem to be fairly well established: it is hereditary, it develops by a method of trial and error in the seventh month of life, it is due to some as yet unknown ascendency of the left hemisphere of the brain. That it is inheritable points to its origin as a congenital variation. That it develops in the seventh month of life points to its dependence upon the ripening of some bodily structure. The precise manner in which it is dependent upon the left hemisphere has never been satisfactorily explained. In fact, the very pertinent question whether the ascendency of the left hemisphere rests in the sensory or motor areas has, seemingly, never been raised. Reflection will show that the initial difference must be sensory and not motor. If the reflex act concept of the manner of working of the nervous system is correct, and if, as a consequence of that concept, currents of innervation flow only from afferent to efferent neurones, always in the "forward direction," it follows that the ascendency of the left hemisphere must, in the first instance, exist in the sensory neurones. For, the contraction of muscles of the right arm is merely a consequence of the discharge of nerve cells in the left motor cortex. But, the discharge of these cells is, again, a consequence, merely, of the discharge of sensory cells which are situated either in the sensory cortex or, possibly, in the periphery. If this reasoning is sound, it follows that where there is motor bilateral asymmetry there must first be sensory bilateral asymmetry.

Experiments[1] carried out during the past year, on the comparative sizes of objects which are seen in indirect vision, brought to light the fact that a marked difference in the perception of size exists between the right and left halves of the retinæ of the two eyes. The experiments were made with a perimeter. The objects compared were the orbits described by two black spots which were borne upon the peripheries of two slowly moving white cardboard discs. The spots were attached to movable radii so that the orbit of the apparently larger disc could be reduced until it equaled, subjectively, the orbit of the smaller. In this way, quantitative measurements were made for four meridians, vertical, horizontal and two oblique, and for three parallels of latitude, 10°, 20° and 25°, of the visual field. The observations were either (*a*) peripheral comparisons, in which the discs were situated in the periphery of the field of vision, upon some one of the four meridians, on opposite sides of the fixation point or (*b*) foveal-peripheral comparisons, in which one disc covered the fixation point and the other occupied some position in the periphery. The results of both (*a*) and (*b*) follow. (i.) The discs on the upper vertical, right-upper oblique, right horizontal and right-lower oblique meridians appear larger than similar discs symmetrically placed on opposite sides of the fixation point or at the fixation point. (ii.) This result is constant for *both* eyes. (iii.) The enlargement is greatest at 25° from the fixation point and least at 10°. (iv.) The enlargement is greater in the right-upper field than in the right-lower field. When it was seen that objects in the right half of the field of vision are imaged upon the left corresponding halves of the retinæ and that these halves of the combined eye are connected with the left occipital hemisphere, it was suggested that the illusion of size might be reversed with left-handed persons, who are, presumably, right-hemisphered. To test this point, crude observations were made with small clay discs and larger cardboard discs, placed upon a table, about 12 cm. apart, in front of the observer. The observer looked with one eye at a time, from a height of about 75 cm., at the middle point between the discs and compared, in indirect vision, their size. 183 observations were made. To 100 persons, the right disc appeared larger to both eyes. To 45 persons, the left disc appeared larger to both eyes. These results, as unequivocal, are the only ones that need be

[1] For a full report on these experiments, see a forthcoming article in *The Psychological Review.*

cited here. Of the 100 persons to whom the right disc appeared larger, 76 were right-handed, 8 ambidextrous, 16 left-handed. Of the 45 persons to whom the left disc appeared larger, 15 were right-handed, 3 ambidextrous, 27 left-handed. These results can not be considered final; but, they do seem to indicate a tendency to a relationship between the peripheral perception of size and right- and left-handedness.

Granted that such a difference in the perception of size does certainly exist between the central and peripheral parts of the retina, the sensory motive, so to call it, which in the discussion of the part played by the left hemisphere, seemed necessary to initiate right-handed movements, would be furnished. Objects situated in the right half of the field of vision of a left-hemisphered infant would, by appearing larger, attract its attention. The eyeballs would then turn, reflexly, to receive the attractive object on the fovea. Eye movements would, probably, lead to head movements, and head movements to arm movements. Just the reverse of this would happen with a right-hemisphered infant. The fact that the predominant use of the right hand is developed by trial and error, is against the assumption that there is a "natural prepotency in the paths to discharge into the right arm." If it were merely reflex, there would be no period of uncertainty in which both arms are used. A fact which supports the view suggested here is that the time (seven months) at which a pronounced right-handedness developed in Baldwin's[1] child was but little later than the time (five months) at which Raehlmann[2] found that an object was recognized when its image fell on the periphery of the retina.

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TERTIARY DEPOSITS OF NORTHEASTERN MEXICO

THE work done in the Tertiary deposits along the Rio Grande border of Texas by Dr. R. A. F. Penrose, Jr., and myself, and described in the First Annual Report of the Geological Survey of Texas and in a later paper entitled "Geology of Southwestern Texas," has been extended southward during the past year by Professor W. F. Cummins as far as the Conchas River.

He finds that the same general divisions which we have described in Texas are easily recognizable for this entire distance of more than one hundred miles, but also finds that, while a large number of the familiar forms of the Texas fossils are found in the various divisions, there are others which were not recognized there. Among these is the occurrence of a *Venericardia*, which Dr. Dall states is allied to *potapacœnsis* of the Maryland Eocene, in beds that are stratigraphically the continuation of the Marine stage of the Texas section. A number of other new forms were also found, which have not as yet been studied.

The beds of the Fayette stage which are exposed on the Rio Grande between Carrizo and Roma extend southward to Mendez on the Conchas and are characterized by the large *Ostrea alabamiensis* var. *contracta* Conrad and other forms.

The beds of the Frio stage which overlie the Fayette here, as farther north, are better exposed in this region than in Texas and carry a very distinctive fauna. Some of the forms collected at San Fernando on the Conchas River were examined by Dr. Dall, who writes that they comprise *Pecten, Arca, Clementia,* etc., and are with little doubt Oligocene. This series of beds, which Professor Cummins calls the San Fernando, was traced by him to the extreme southern limit of the Tertiary, some forty miles south of the mouth of the Soto Marina River.

Very few fossils were found in the Frio deposits in Texas and such as were determinable seemed to warrant its reference to the Eocene, but Professor Cummins's later discoveries show this to be incorrect and in place of being of Lower Claiborne age, it should be placed with the Oligocene.

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[1] "Mental Development, Methods and Processes," p. 64.

[2] Cited, without reference to the original, by Schaefer, "Text-book of Physiology," Vol. II., p. 759.